DOCUMENT RESUME

ED 246 377 CG 017 619

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TITLE Multistage Path Models of Adolescent Alcohol and Drug Use: A Reanalysis.
SPONS AGENCY California Univ., Riverside.
PUB DATE Apr 84
NOTE 32p.; Expanded version of a paper presented at the Annual Convention of the Rocky Mountain Psychological Association (Las Vegas, NV, April 25-28, 1984).
PUB TYPE Reports - Research/Technical (143) -- Speeches/Conference Papers (150)

EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS *Adolescents; Age Differences; Alienation; *Drinking; *Drug Abuse; Models; Parent Child Relationship; *Path Analysis; *Personality Traits; Secondary Education; Social Behavior
IDENTIFIERS Social Learning Theory

ABSTRACT

Using a path analysis on simplex pattern models of adolescent drug use, Potvin and Lee (1980) studied the personality and perceived environmental variables associated with drug use. To evaluate the appropriateness of the drug use models derived by Potvin and Lee, a structural modeling methodology using LISREL VI was applied to the data from their study. The Potvin and Lee study used interview data from a national probability sample of 585 girls and 536 boys, divided into three age groups: early adolescence (13-14 year olds); middle adolescence (15-16 year olds); and late adolescence (17-18 year olds). An analysis of the results showed that contrary to the original results reported by Potvin and Lee, a nonsimplex pattern of relations among different forms of drug use was found to hold for two of the three different age groups sampled (early adolescence and late adolescence). The personality dimensions of conformity-commitment and religiousness had consistent negative effects on drug use in each sample. Among young adolescents, increased conformity led directly to decreased marijuana use. Parental support-affection and parental approval of friends had effects on drug use in two of three samples (middle adolescence and late adolescence). Self-esteem and alienation were consistently unrelated to drug use. These findings suggest that the reanalysis of the Potvin and Lee study provided a more comprehensive test of theoretical models of drug use. (Author/BL)

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Multistage path models of adolescent alcohol and drug use: A reanalysis

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Path models of alcohol and drug use

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alienation; control theory; differential association theory; parental support-affection; religiousness; self-esteem; simplex model; social learning theory; stage theory

Abstract

Structural models containing personality and perceived environment variables as predictors of current drug use were compared. Contrary to the original results reported by Potvin and Lee, a nonsimplex pattern of relations among different forms of drug use was found to hold for two of the three different age groups of adolescents sampled. The personality dimensions of conformity-commitment and religiousness had consistent negative effects on drug use in each sample; parental support-affection and parental approval of friends had effects on drug use in two of three samples; and self-esteem and alienation were consistently unrelated to drug use. The reanalysis of the Potvin and Lee study provided a more comprehensive test of theoretical models of drug use, resulting in an explicit examination of assumptions and in findings differing in important respects from the original analysis.

The importance of an interactionist, multivariate theoretical framework for understanding adolescent alcohol and drug use is increasingly emphasized (e.g., Jessor, 1982; Sutker, 1982). Simultaneous consideration of the personality, perceived environment, and behavioral systems has been found to be more useful than simplistic, univariate explanations of substance use (Pandina & Schuele, 1983).

The importance of personality in explaining drug use has received varying degrees of empirical support, depending on the variables examined. "Among the attributes frequently labeled as personality traits, one factor consistently stands out as a drug use precursor: a predisposition toward rebellion, independence, and nonconformity" (Polich et al., 1984, p. 127). Adolescents who use drugs tend to place higher value on independence and autonomy, lower value on academic achievement. have lower expectations of school achievement, hold a more critical attitude toward conventional society, are more tolerant of social norm transgressions, and are lower in religiosity (Jessor, 1983).

The relationship of personality factors such as self-esteem, alienation, and anomie to alcohol and drug use is more problematic (Polich et al., 1984). In one sample, Donovan et al. (1983) found that self-esteem in early youth was negatively correlated among males and positively corre-

lated among females with problem drinking in young adulthood. In a second sample in this study, self-esteem in adolescence was uncorrelated with problem drinking in young adulthood (Donovan et al., 1983). Hays (1980) reported significant correlations between alienation and solitary drinking, times "high" on alcohol, times drunk, and problem drinking in a sample of young adults. In addition, frequency of marijuana use and involvement with marijuana were significantly associated with alienation for males in the sample. But, alienation was not correlated with alcohol or other drug use in an older adult sample examined in the same study (Hays, 1980).

The perceived environment or "environment that is constituted by the actor from his experience with it" (Jessor and Jessor, 1977, p. 27) has been linked to adolescent drug use behavior. For example, the quality of the parent-child relationship, as reflected by the degree of perceived parental affection and support, is an important deterrent to adolescent drug use (Jessor, 1979; Jessor and Jessor, 1977). Similarly, perceived peer drug use and approval of drug use have been identified as some of the strongest predictors of self-reported drug use. Adolescents who interact regularly with peers who use certain drugs tend to use the same drugs themselves (Huba et al., 1979).

In an effort to integrate personality and perceived environment variables within a conceptual model of adolescent drug use, Potvin and Lee (1980) included measures of parental affection and support, parental approval of friends, conformity, religiousness, self-esteem, and alienation as predictors of current use of alcohol, marijuana, and other drug use. A three-stage recursive path model constituted the basic model conceptualized by Potvin and Lee. The model specifies that the "background" variables (parental support and affection, parental approval of friends, and religiousness) have direct effects on the "intermediate" variables (self-esteem, conformity-commitment, alienation) and the behavioral variables (alcohol use, marijuana use, other drug use). In addition, the intermediate variables are hypothesized to have direct effects on alcohol, marijuana, and other drug use.

Using path analysis, Potvin and Lee estimated the above model. Then, they derived more parsimonious models "by eliminating all paths less than two units of their estimation errors" (Potvin and Lee, 1980, p. 536). Though not explicit, it appears that Potvin and Lee removed all nonsignificant paths simultaneously rather than in a sequential order in which one nonsignificant path is removed at a time as a model is revised and reanalyzed.

Although the path analytic technique used by Potvin and Lee requires an explicit specification of a substantive model and it provides an indication of the amount of variance explained by a model, it does not permit an assessment of the statistical significance of fit of the model to the data. Jöreskog (1974, 1978) has proposed a method for maximum likelihood estimation of parameters of structural models hypothesized to underlie observed correlations (or covariances) among measures. Using this procedure, models can be evaluated with relatively precise decision-making criteria. Hypothesized models are evaluated typically in terms of the goodness-of-fit of the model to data and the size and statistical significance of parameter estimates. The various measures of goodness-of-fit have a common goal--to index the degree of similarity between the observed covariances or correlations among measures and the reproduced covariances or correlations generated by the model.

The models proposed and analyzed by Potvin and Lee were based on a simplex pattern of drug use and were not evaluated against nonsimplex models. A simplex model hypothesizes a "chain reaction" between different drugs: alcohol use directly effects marijuana use, and marijuana use directly influences hard drug use. A less restrictive model, a nonsimplex model, allows alcohol, marijuana, and hard drug use to be freely intercorrelated. Although several

independent studies have established that a simplex model is appropriate for describing both initiation of drug use and cumulative drug use patterns (Donovan and Jessor, 1983; Huba, 1983; Huba and Bentler, 1983; Kandel, 1975), a nonsimplex model was found to provide a more acceptable representation of current drug use than a simplex model (Hays et al., 1984). A comprehensive study of both cumulative and current drug use patterns verified that a simplex model was substantively correct for cumulative drug use, but the most appropriate model for current drug use varied with the response format of the drug use question (Hays, 1984). Thus, the most appropriate model, simplex versus nonsimplex, needs to be assessed empirically rather than assumed a priori.

In the present study, we apply structural modeling methodology (Jöreskog, 1974, 1978) to the data presented by Potvin and Lee (1980) in order to evaluate comprehensively the appropriateness of the drug use models they derived.

Methods

The national master sample of the Gallup organization was used by Potvin and Lee (1980) to draw a national probability sample of 13-18 year-olds. A total of 585 girls and 536 boys (representing a 70% interview completion rate) were interviewed in their households for the study.

Included in the interview were measures of background: parental support-affection (a ten-item scale developed by Potvin and Suziedelis, 1969, cited in Potvin and Lee, 1980), parental approval of friends (a single item with five response options), and religiousness (a five-item scale developed by Potvin et al., 1976, cited in Potvin and Lee, 1980); personality: self-esteem (a seven-item scale developed by Rosenberg, 1971, cited in Potvin and Lee, 1980), conformity-commitment (a two-item index having dichotomously scored items), and alienation (five items from the normlessness scale developed by Dean, 1961, cited in Potvin and Lee, 1980); and drug use (three separate items assessing frequency of use of alcohol, marijuana, and other drugs in the last year). These nine measures constituted a nine-by-nine correlation matrix among observed or manifest variables.

Data Analytic Strategies

In this reanalysis of the Potvin and Lee (1980) data, simplex and nonsimplex models of drug use were compared using maximum likelihood estimation of structural equation models with LISREL VI (Jöreskog and Sörbom, 1983). Structural modeling represents a method of theory testing with correlational data in which a sample of data may be assessed with respect to population models that hypothesize certain

relationships between constructs of theoretical interest. The chi square provided in this procedure indicates whether the correlation matrix reproduced by a given model is significantly different from the observed correlation matrix. Statistical nonsignificance implies that a model fits the data well and, thus, provides an adequate representation of the data. Unfortunately, the likelihood of rejecting a model based on chi square is dependent upon sample size. On the one hand, models that explain essentially all of the relevant information in a set of data based on a very large sample size may still be rejectable on statistical grounds (Bentler and Bonett, 1980). On the other hand, too many models may appear to provide adequate fit to data from small samples if only statistical significance is relied upon. To complement the results of the chi-square statistic, two measures of practical fit, rho and delta (proposed by Bentler and Bonett, 1980), not influenced by sample size, were employed in this study. Rho (nonnormed) and delta (normed) provide measures of practical significance because they represent the proportion of statistical information in the data that is accounted for by a model. Bentler and Bonett (1980) suggested that models with rho or delta values less than .90 should not be accepted, because such models can often be easily and substantially improved. If rho and delta are greater than .95 for a given model, the model is

generally considered an acceptable representation of the data (Tucker and Lewis, 1973).

Analyses with LISREL VI provide modification indices that estimate the improvement in fit that would accompany the relaxing of a fixed parameter. It is reasonable to respecify a model according to these indices if the adjustments have a substantive basis, although this stage of an analysis is regarded as more exploratory than confirmatory. Models resulting from this procedure may be regarded as provisional, requiring replication. Replications with different kinds of analysis (Huba & Bentler, 1982) or across new samples of subjects (e.g., Cudeck & Browne, 1983) will help substantiate a given model. Although models obtained with different analytic strategies or samples may differ in some respects, they may sometimes lead to the same general conclusions. A model does not need to be completely invariant across situations to support some important substantive hypotheses (e.g., Jöreskog, 1971).

Using structural modeling techniques, it is possible to parameterize two structural models in such a way that one (simplex model) is a subset of the other (nonsimplex model). A nonsimplex model can be evaluated that differs from the corresponding simplex model in that the former specifies both a direct and an indirect (through marijuana) path from

alcohol to hard drug use while the latter hypothesizes no such direct path. Because the simplex model requires one fewer parameter estimate and is nested within the common factor model, it is impossible for the simplex model to fit the data better than the nonsimplex model, but a statistical test of difference in fit between the two models may be computed. If it fits the data virtually as well as the common factor model, the simplex model may be regarded as substantively correct.

Chi-square difference tests are appropriate when comparing nested models and were used to test the difference in fit of models estimated using the method of maximum likelihood. A significant chi-square difference test value indicates that a less restricted model explains a significantly greater amount of covariance among measures than does a more restricted model. Differences in the magnitude of rho and delta between models were also examined.

The causal impact of one variable on another was estimated by summing direct effects, in which a variable influences another variable unmediated by other variables, and indirect effects, in which a variable influences another variable through its impact on one or more intervening variables, which impact on the variable examined.

Procedure

The basic simplex model proposed by Potvin and Lee (1980) was estimated for each of three age groups: early adolescence (13-14 year-olds), middle adolescence (15-16 year-olds), and late adolescence (17-18 year-olds). The fit of the basic simplex model was then compared with the corresponding nonsimplex model within each of the three subgroups. Next, nonsignificant causal parameters were deleted in a sequential manner from the nonsimplex model based on the the size of the t-test statistic representing the ratio of parameter estimate divided by standard error. Parameters were deleted one at a time until all the estimates remaining in the models were statistically significant. Then, the modification indices provided by LISREL VI were examined to determine if additional parameters should be included. After the unnecessary parameters were excluded and all necessary parameters included in the model, a final nonsimplex model was obtained. Lastly, the direct path from alcohol to other drug use was constrained to zero, thereby forming a final simplex model. The fit of this final simplex model was then compared with that of the final nonsimplex model.

Results

Early Adolescence (13-14 year-olds)

A null model specifying no causal influences was estimated first. This model, Model 0A, was easily rejectable, $\chi^2(36, N=416)=552.17$, $p<.01$). Thus, the hypothesis of lack of correlation among the variables for this subgroup was not tenable. Next, the basic simplex model, Model 1A in Table 1, was evaluated. Model 1A was statistically rejectable ($\chi^2(4, N=416)=27.78$, $p<.01$) and displayed inadequate fit in terms of practical significance. The corresponding nonsimplex model, Model 2A, was also rejectable on statistical and practical grounds, but it provided a significant improvement in fit over Model 1A ($\chi^2(1, N=416)=6.36$, $p<.05$).

Insert Table 1 About Here

A final nonsimplex model, Model 3A, was obtained by eliminating statistically unnecessary parameters and including statistically significant parameters. Model 3A could not be rejected either statistically ($\chi^2(19, N=416)=20.87$, $p>.05$) or practically (rho=0.99, delta=0.96). The corresponding simplex model, Model 4A, fit the data significantly less well statistically ($\chi^2(1, N=416)=6.26$, $p<.05$) and practically (Δrho= -.02, Δdelta= -.01) than Model 3A. Thus, a nonsimplex model can be regarded as substantively correct for the early adolescence subgroup.

Figure 1 presents Model 3A, the final nonsimplex model for the early adolescence subgroup. As in the Potvin and Lee analyses, neither alienation nor self-esteem were significant influences on alcohol and other drug use in this and the other subgroups. Model 3A differs from the final model presented by Potvin and Lee for this subgroup in two principal ways. First, Model 3A contains a path representing the direct effect of alcohol on other drug use that was not present in the simplex model proposed by Potvin and Lee. This difference can not be emphasized enough: For the early adolescence subgroup, a nonsimplex model is a more appropriate representation of the data than a simplex model. Secondly, Model 3A contains a path representing the direct effect of conformity-commitment on marijuana use that was not present in the Potvin and Lee article. The absence of this path in the original article may have been the result of an oversight by the authors, because this effect was statistically significant in the basic model (and therefore should have been retained in the parsimonious model).

Insert Figure 1 About Here

Middle Adolescence (15-16 years-old)

The null model, Model 0B, was rejectable ($\chi^2(36, N=391)=706.71$, $p<.01$). The basic simplex model, Model 1B,

was also rejectable ($\chi^2(4, N=391)=19.26$, $p<.01$) and displayed inadequate fit in terms of practical significance. However, the fit of Model 1B did not differ significantly from the fit of the corresponding nonsimplex model, Model 2B ($\chi^2(1, N=391)=0.21$, $p>.05$). In fact, Model 1B provided better fit in terms of practical significance, according to the non-normed measure of practical fit (Δrho=.08).

After retaining only statistically significant parameters, the resulting nonsimplex model, Model 3B, could not be rejected ($\chi^2(17, N=391)=16.32$, $p>.05$). The corresponding simplex model, Model 4B, did not differ significantly from Model 3B, either statistically ($\chi^2(1, N=391)=0.44$, $p>.05$) or practically (Δrho=.00, Δdelta=.00). Thus, the simplex model can be accepted as substantively correct for the middle adolescence subgroup.

Figure 1 presents Model 4B, the final simplex model for the middle adolescence subgroup. Model 4B differs from the parsimonious model provided by Potvin and Lee in that the direct effect of religiousness on other drug use is present in Model 4B but absent from Potvin and Lee's model. Thus, religiousness acts as a significant constraining influence on other drug use as well as on marijuana and alcohol use.

Late Adolescence (17-18 year-olds)

The null model, Model 0C, was rejectable statistically ($\chi^2(36, N=314)=715.28$, $p<.01$). The basic simplex model, Model 1C, was also rejectable ($\chi^2(4, N=314)=31.48$, $p<.01$). The basic nonsimplex model, Model 2C, fit the data significantly better than Model 1C, both on statistical ($\chi^2(1, N=314)=10.18$, $p<.01$) and on practical grounds ($\Delta rho= -.04$, $\Delta delta= -.01$).

A final nonsimplex model, Model 3C, was obtained by retaining only significant parameters. Model 3C could not be rejected statistically ($\chi^2(16, N=314)=15.37$, $p>.05$) and fit the data quite well in terms of practical significance (rho=1.00, delta=0.98). The corresponding simplex model, Model 4C, fit the data significantly less well statistically ($\chi^2(1, N=314)=9.54$, $p<.01$) and practically ($\Delta rho= -.03$, $\Delta delta= -.01$) than Model 3C. Thus, the nonsimplex model provides the more acceptable representation of the data for the late adolescence subgroup.

Figure 1 provides Model 3C, the final nonsimplex model for the late adolescence subgroup. Three estimates differ between Model 3C and the parsimonious model given by Potvin and Lee. First, the direct effect of alcohol on other drugs is present in Model 3C but it is not present in the Potvin and Lee model. In addition, religiousness exerts a positive direct effect on other drug use in Model 3C but no direct

effect in the Potvin and Lee model. It is important to note that although the estimated direct effect of religiousness on other drugs is positive, the estimated indirect effect is negative. More importantly, the total estimated effect (direct and indirect effects) of religiousness on other drug use is negative, consonant with substantive expectations (see Table 2). Finally, the correlation between parental support-affection and religiousness was nonsignificant in Model 3C, but this correlation was given by Potvin and Lee.

Insert Table 2 About Here

The final models for the different age groups each contain one or more parameters not included in Figure 1. For both the early and middle adolescent groups, correlations between residuals were specified between self-esteem and conformity-commitment and between self-esteem and alienation. In the late adolescent group, a correlation was specified between the residual from self-esteem and the residual from alienation. Relationships among these variables are potentially important, but there were no compelling a priori reasons to estimate direct effects between them.

Discussion

Recent research by Hays et al. (1984) found that a non-simplex pattern provides a better representation of current

drug use data in contrast to the simplex pattern often found for measures of lifetime drug use or initiation of drug use (e.g., Huba and Bentler, 1983). Supporting this research on current drug use, the present reanalysis of the Potvin and Lee data found a nonsimplex model to be a more appropriate representation of these data than a simplex model for two of the three subgroups (early adolescence and late adolescence). The finding that a nonsimplex model better represents the data than a simplex model for the early adolescence and late adolescence subgroups indicates that the original simplex specification by Potvin and Lee was not justifiable by the data, although the fit of the simplex model to the data for the middle adolescence subgroup is supportive of the assumption upon which the original analyses were based. In the Potvin and Lee (1980) study these assumptions were not tested. The present reanalysis, along with previous research (Hays, 1984; Hays et al., 1984), shows that current drug use patterns are less simple (i.e., simplex) than cumulative and initial drug use patterns and that the causal priority among measures of alcohol and other drug use can not be assumed a priori.

As also concluded in the study by Potvin and Lee, the present research found conformity-commitment to have an important direct influence on alcohol use in all the adolescent age groups. In addition, the present study found that

increased conformity led directly to decreased marijuana use among young adolescents, whereas Potvin and Lee did not report this effect. This age group also demonstrated that other drug use was influenced indirectly by the impact of conformity-commitment on alcohol and marijuana use, which then affected other drug use. In the other age groups, conformity-commitment did not affect marijuana use or other drug use directly and its indirect effects were quite small. Taken together, these results and reviews of other research (e.g., Jessor, 1983; Polich et al., 1984) demonstrate that conformity is a consistent predictor of alcohol use and, in some instances, use of marijuana and other drugs.

In both this study and the Potvin and Lee (1980) study, religiousness was found to deter alcohol use among all age groups. In the present study, it had the greatest overall influence of all the psychological variables on use of alcohol and other drug use among all age groups, and the total effects were larger for the 15-16 and 17-18 year olds than for the 13-14 year-old group. The present study included a direct path from religiousness to other drug use for both 15-16 and 17-18 year olds, while the Potvin and Lee study did not.

The other predictor variables in the structural models exhibited less influence on drug use. Parental approval of

friends had a direct impact on alcohol use in the middle adolescent group and on use of marijuana and other drugs in the late adolescent group. The total effect of parental support-affection on alcohol use among individuals in the late adolescence subgroup was noteworthy, but this measure and the measures of alienation and self-esteem, were not predictors of drug use in general. The nature of these findings is not surprising given that alienation and self-esteem were inconsistently related to drug use in other research (Donovan et al., 1983; Hays, 1980). Self-esteem and alienation may be correlated with drug use in some samples, but this correlation may be shown to be spurious when other variables are included in a multivariate model in which partial effects are estimated.

The number of direct paths on drug use was found to increase with age in this research and the Potvin and Lee (1980) study. But, the differences in the correlates of alcohol and other drug use as a function of age may be artifactual. Such findings may stem from attenuated correlations resulting from restrictions of range and radically skewed distributions for some of the variables measured in the younger age groups. This is a reasonable contention because rates of hard drug use among young adolescents are lower than rates of use among older adolescents. When age differences are examined, the nature of the distributions of

variables need to be examined carefully before theoretical conclusions based on age differences are proposed.

The present study found that comprehensive structural modeling procedures yielded different, theoretically important results from the original analysis reported by Potvin and Lee (1980). In general it appears that a nonsimplex model of drug use fits current drug use data better than does a simplex model and that religiousness and conformity-commitment are consistent constraining influences on adolescent alcohol use.

Acknowledgements

Preparation of this article was supported in part by a University of California, Riverside Fellowship and a Grant-in-Aid of Research to the first author from Sigma Xi, the Scientific Research Society. This paper is an expanded version of a paper presented at the meeting of the Rocky Mountain Psychological Association, Las Vegas, Nevada, April, 1984.

Thanks are due to Pam Sonksen for her assistance with this study.

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Table 1

Goodness-of-Fit Indices for Structural Equation Models

Model	df	2	prob.	rho	delta
Ages 13-14 (n=416)					
OA. Null	36	552.17	.000	----	----
1A. Basic simplex	4	27.78	.000	.585	.950
2A. Basic nonsimplex	3	21.42	.000	.572	.961
3A. Final nonsimplex	19	20.87	.344	.993	.962
4A. Final simplex	20	27.13	.132	.975	.951
Ages 15-16 (n=391)					
OB. Null	36	706.71	.000	----	----
1B. Basic Simplex	4	19.26	.001	.795	.973
2B. Basic nonsimplex	3	19.05	.000	.713	.973
3B. Final nonsimplex	17	16.32	.501	1.002	.977
4B. Final simplex	18	16.76	.540	1.004	.976
Ages 17-18 (n=314)					
OC. Null	36	715.28	.000	----	----
1C. Basic simplex	4	31.48	.000	.636	.956
2C. Basic nonsimplex	3	21.30	.000	.677	.970
3C. Final nonsimplex	16	15.37	.497	1.002	.979
4C. Final simplex	17	24.91	.097	.975	.965

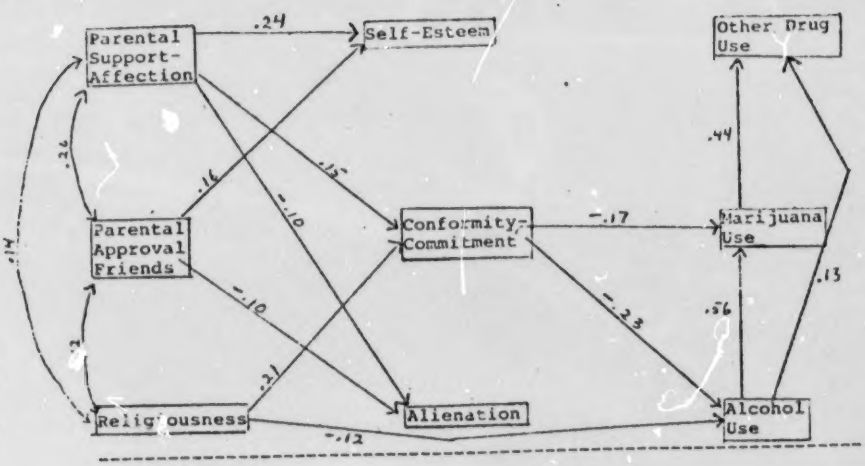
Table 2

Estimated Effects of Predictor Variables on Alcohol and Drug Use

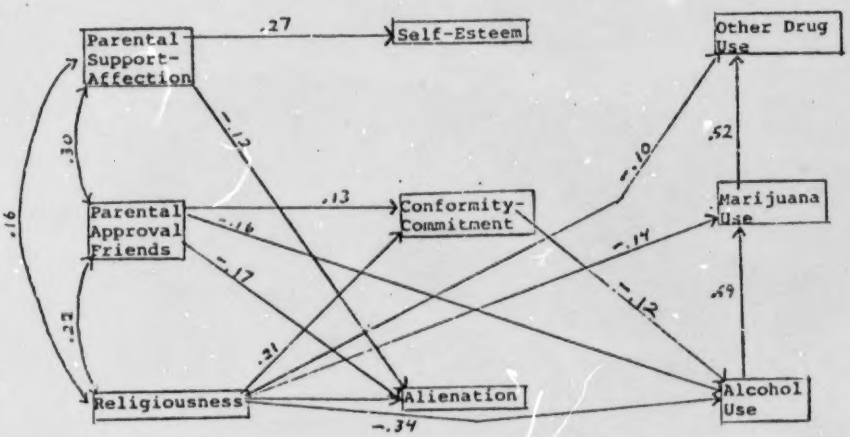
	ALCOHOL			MARIJUANA			OTHER DRUG USE		
	13-14	15-16	17-18	13-14	15-16	17-18	13-14	15-16	17-18
Parental Support-Affection	-.03	.00	-.15	-.04	.00	-.08	-.02	.00	-.07
Parental Approval of Friends	.00	-.16	-.02	.00	-.09	-.16	.00	-.05	-.25
Religiousness	-.17	-.34	-.29	-.13	-.18	-.31	-.07	-.28	-.10
Self-Esteem	.00	.00	.00	.00	.00	.00	.00	.00	.00
Conformity-Commitment	-.23	-.12	-.15	-.30	-.07	-.08	-.16	-.04	-.06
Alienation	.00	.00	.00	.00	.00	.00	.00	.00	.00

Figure 1. Final path models of background and personality variables as predictors of alcohol and other drug use. Model 3A is presented for 13-14 year olds, Model 4B for 15-16 year olds, and Model 3C for 17-18 year olds.

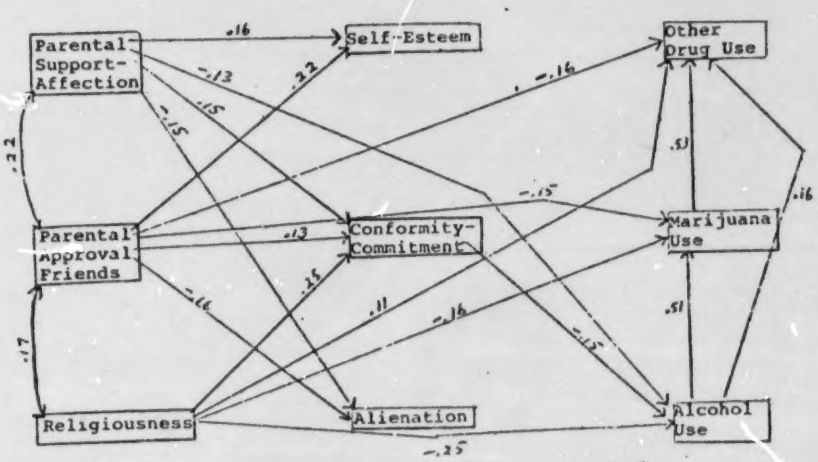
Ages 13-14



Ages 15-16



Ages 17-18



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